Garreis, Mary Jo.

Heavy Metal, Polychlorinated Biphenyl, and Pesticide Levels in Oysters *(Crassostrea virginica)* and Soft Shell Clams *(Mya arenaria)* from the Kent Island Coast, Maryland

Mary Jo Garreis, Faith A. Pittman
Water Management Administration
Office of Environmental Programs
Department of Health and Mental Hygiene

INTRODUCTION

Purpose of Study

The Office of Environmental Programs, Maryland Department of Health and Mental Hygiene routinely tests the oysters *(Crassostrea virginica)* and soft shell clams *(Mya arenaria)* taken from the Chesapeake Bay and its tributaries for the presence of bacteria, pesticides and heavy metals. The shellfish monitoring program verifies that the shellfish are fit for human consumption and do not present any public health risk. The shellstock data for the Kent Island coast underwent extensive analysis to establish an inventory of heavy metal, PCB and pesticide levels in oysters and soft shell clams. Results were analyzed for conformance with any heavy metal or pesticide standards set by the Food and Drug Administration. Pesticide and heavy metal baseline values for oysters and softshell clams along the Kent Island coast were determined. Knowledge of baseline or "normal" levels makes it possible to determine the impact man-made as well as natural events have on the ecosystem and provides information needed for good management decisions.

Study Area Description

Kent Island is located in Queen Annes County on the Eastern Shore of Maryland. The island is approximately 23.4 kilometers long from Love Point at its northern end to Kent Point at its southern end (Figure 1). Oysters and soft shell clams were collected along the west coast of the island.

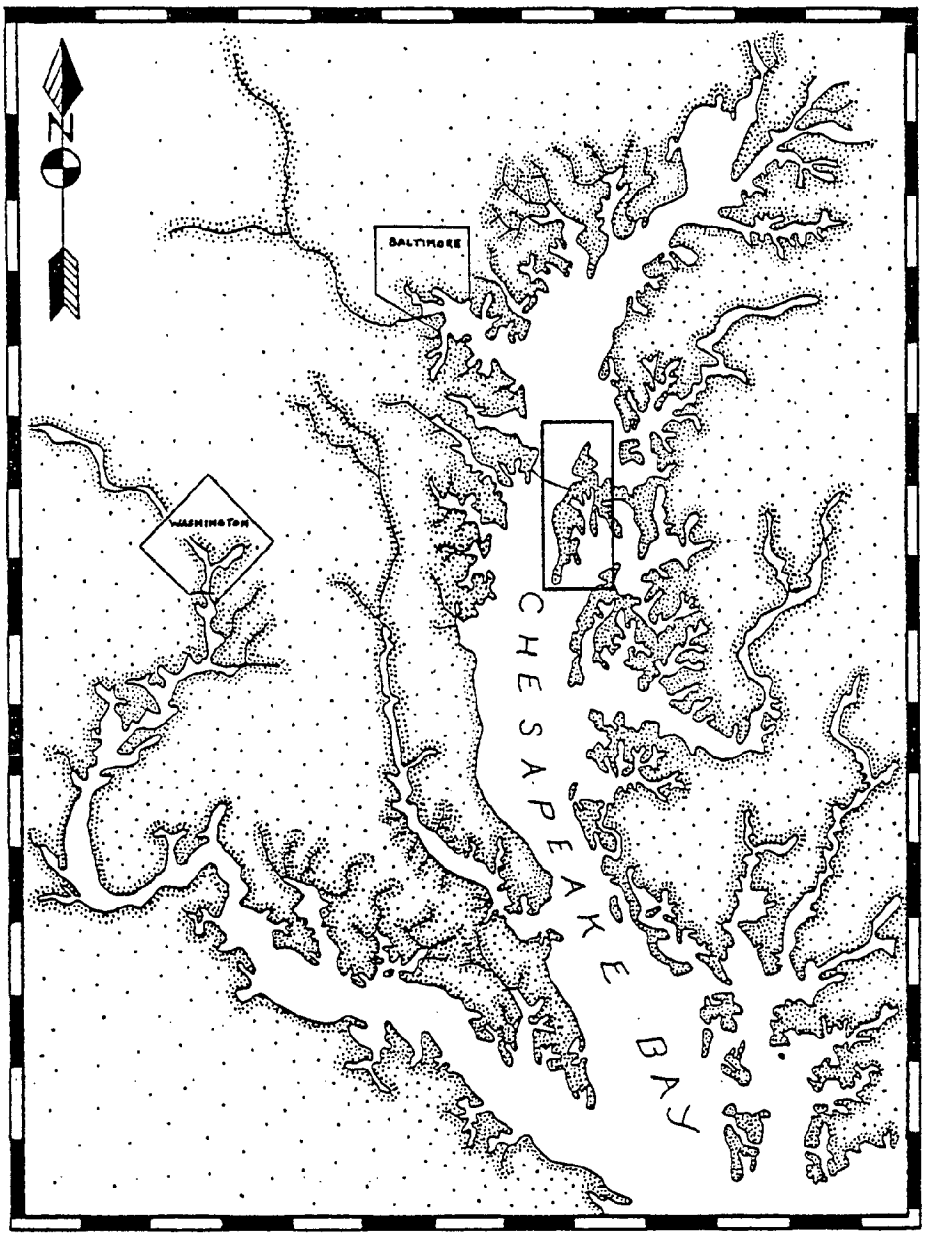
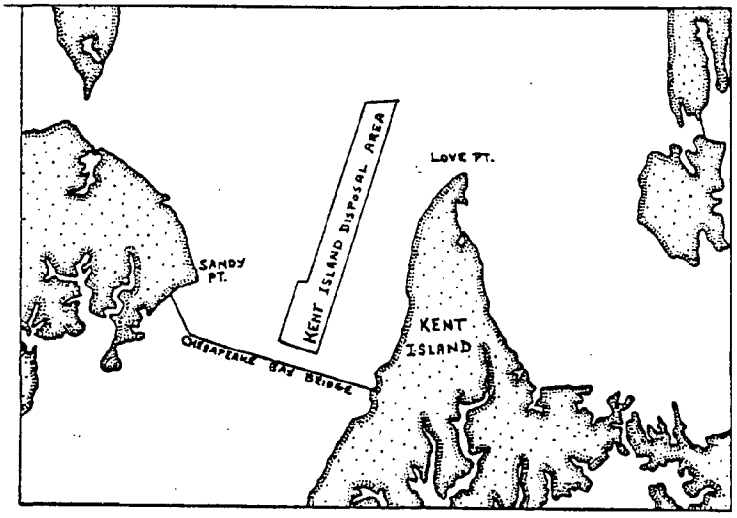


Figure 1 Kent Island, Chesapeake Bay Maryland

Kent Island is approximately 9.7 kilometers from Maryland's western shore in the area of the Chesapeake Bay Bridge which connects the two shores. A dumping ground for spoil disposal was located off Kent Island by the U.S. Army Corp of Engineers in November, 1924 (Figure 2). The disposal site has been used as recently as 1976 to receive spoils from maintenance dredging operations in Baltimore Harbor approach channels. Evaluation of the effects, if any, of the Kent Island Spoil Disposal Site on heavy metal, PCB and pesticide levels in shellstock was not possible, however, due to insufficient data.



METHODS AND MATERIALS

Sample Collection

Maryland Department of Health and Mental Hygiene monitors oysters *(Crassostrea virginica)* and soft shell clams *(Mya arenaria)* from the Chesapeake Bay and its tributaries. The shellfish meats are tested for heavy metal, polychlorinated biphenyl (PCB), pesticide contamination. Samples are collected directly from commercial harvesting boats working

in an area or are hand dredged by Department personnel. Twenty-eight (28) oysters samples from ten (10) locations and forty-five (45) soft shell clams from thirteen (13) locations were taken along the Kent Island coast area between 1972 and 1979 (Figure 3). All shellfish used in the analyses were adult animals of commercial size. Commercial sizes for shellstock in the State of Maryalnd are ~~1.5~~ ≥2 inches for soft shell clams and ~~3~~ ≥3 inches for oysters.

Laboratory Analyses

The shellfish were scrubbed clean, shucked and drained and the shells discarded. Each sample was a composite of soft shell clam or oyster meats collected from a single location. The number of animals used in each sample was determined by the grams of tissue necessary for the analyses. For pesticide and PCB analysis, approximately 200 grams of shellfish meat was homgenized and a 100 gram portion was analyzed. All PCB and pesticide analyses were in accordance with the Food and Drug Administration's Pesticide Analytical Manual (1977).

For heavy metal analysis, approximately 200 grams of shellfish meats were homgenized and 20-30 grams of the homogenate were used for all heavy metal analyses except mercury and arsenic. Analysis for mercury required 5-10 grams of homogenate. The shellfish were analyzed for copper, zinc, cadmium, chromium and lead in accordance with Chemical Procedures: NSSP - Collection, Preparation and Analysis of Trace Metals in Shellfish (1975). Arsenic was analyzed in accordance with Official Methods of Analysis of the Association of Official Agricultural Chemists (1975) and mercury was analyzed in accordance with methods presented by Munns and Holland (1977). Heavy metal, PCB and pesticide laboratory results were recorded in parts per million (ppm) wet weight. Results of lead, chromium and arsenic analyses were sometimes recorded as less than (<) detectable limits. The limits of detectable levels were changed as laboratory methods became more accurate over the years.

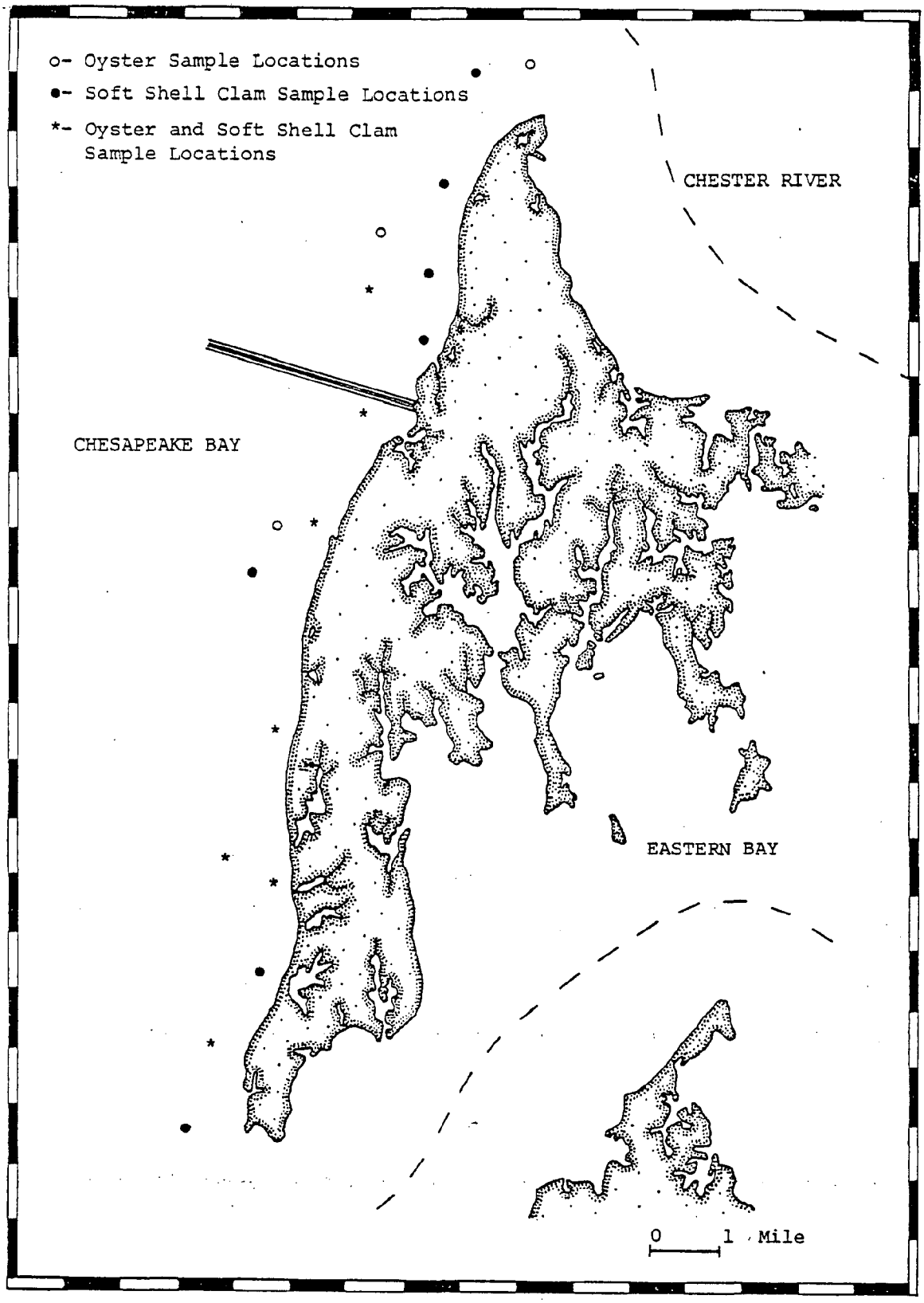


Figure 3 Sample locations along Kent Island Coast

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Statistical Analyses

Heavy metal, PCB and pesticide levels in oysters were compared to the levels in soft shell clams. The Student's *t*-test at the 5% level was used to determine significant differences. Where two means had unequal variances, the Student's *t*-test (approximation method) was used (Steel and Torrie, 1960). The shellstock samples with non-detectable levels were assigned the value of zero in the statistical testing of PCB and pesticide means. Statistical tests were not conducted for lead, chromium and arsenic.

Oyster data were evaluated to determine possibe year trends. To eliminate seasonal effects only those years (1975, 1979 and 1981) where data were available from April and May were used. Heavy metal, PCB and pesticide means were graphed.

RESULTS

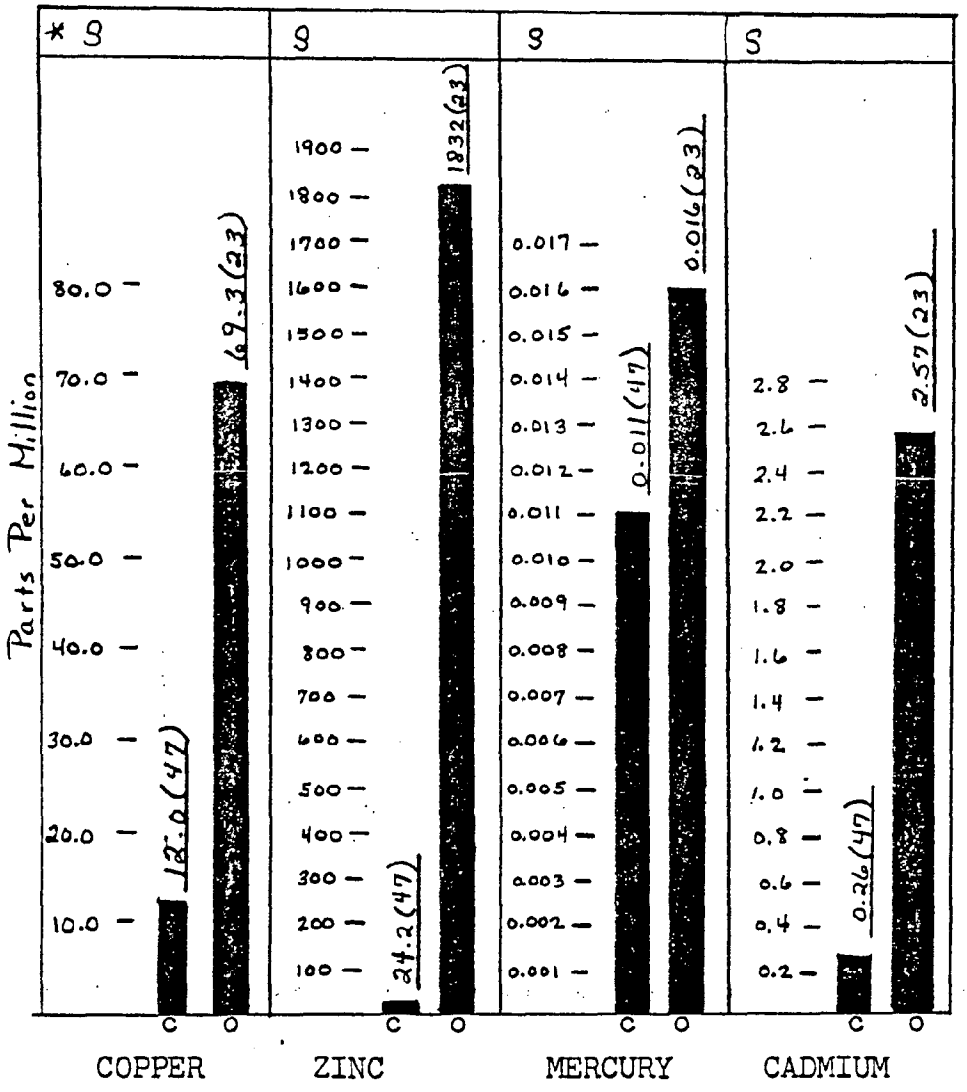
Heavy Metals

Statistical ~~paranthesis~~ parametric for copper, zinc, mercury and cadmium were determined for oysters and soft shell clams (Table 1). The only heavy metal for which the Food and Drug Administration has established an action level standard is mercury. The maximum level of mercury allowable in shellfish is 1.0 ppm. No oyster or soft shell clam samples had levels approaching or exceeding the standard.

Table 1 - Heavy Metal Parameters Calculated for Oysters (o) and Soft Shell Clams (c)
(Expressed in parts per million (ppm))

Heavy metal	Species	Range (ppm)	Mean (ppm)	Standard deviation (ppm)	Median (ppm)	# samples positive / Total # samples	% samples positive
Copper	o	18.9-118.4	69.3	29.7	77.0	23:23	100
	c	2.4-18.5	12.0	3.5	11.98	47:47	100
Zinc	o	578-2619	1832	631	1997	23:23	100
	c	14.0-33.4	24.2	4.8	23.9	47:47	100
Mercury	o	0.007-0.026	0.016	0.006	0.013	23:23	100
	c	0.003-0.022	0.011	0.005	0.011	47:47	100
Cadmium	o	1.02-5.16	2.57	1.02	2.55	23:23	100
	c	0.10-0.44	0.26	0.09	0.26	47:47	100

Figure 3 compares oyster and soft shell clam heavy metal means in graph form. Significant differences between species according to the student's *t*-test at the 5% level are indicated at the top of each column.



*S=significant according to Student's t-test at 5% level

Figure 3 Heavy metal means in soft shell clams (c) and oysters (o) from the Kent Island Coast

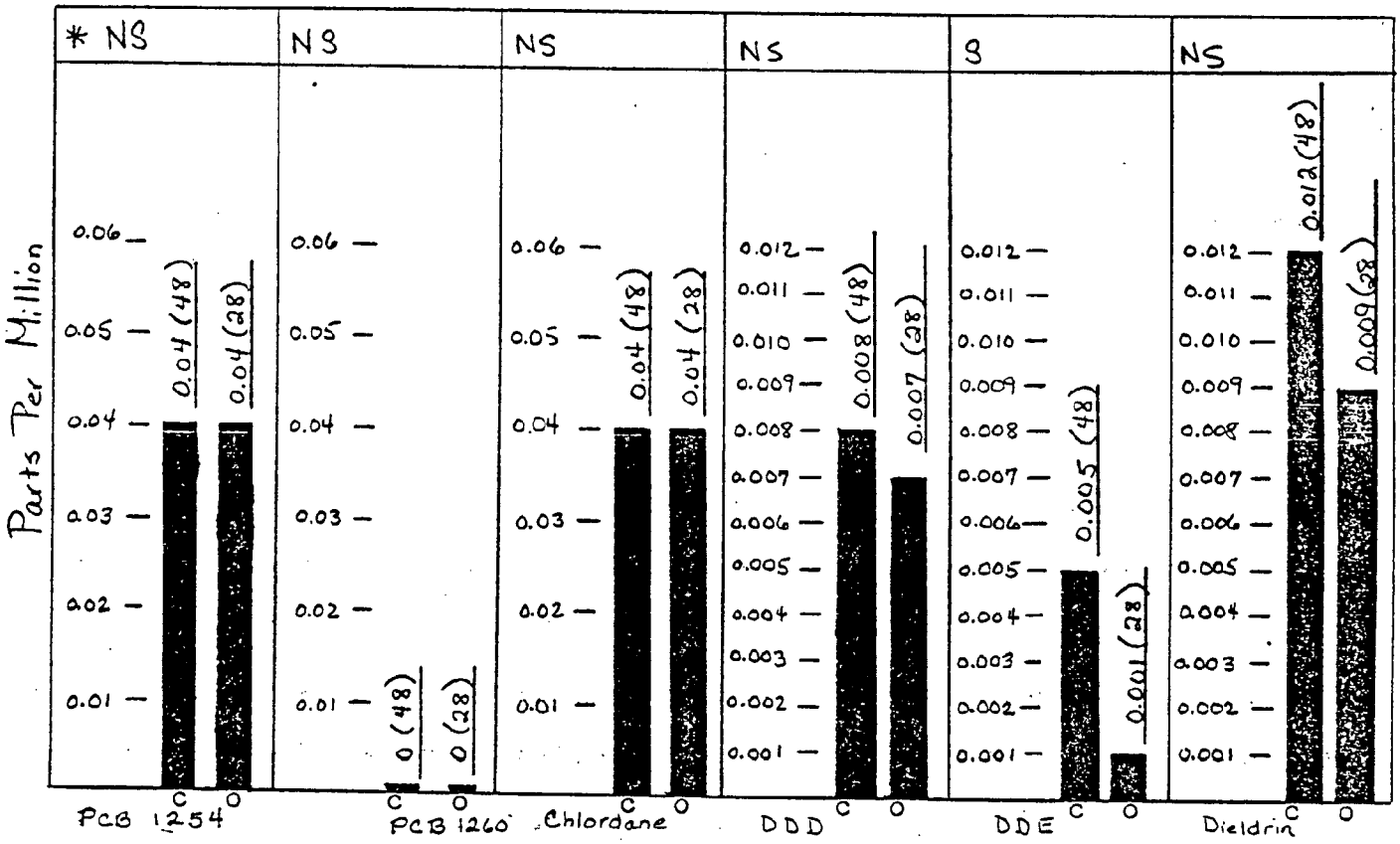
Pesticides

Statistical parameters for PCB 1254, PCB 1260, chlordane, DDD, DDE and dieldrin were determined for oysters and soft shell clams (Table 2). None of the oyster or softshell clam samples exceeded the five (5) ppm action level guidelines for PCBs established by the Food and Drug Administration.

Table 2 - Pesticide and PCB Paramters Calculated for Oysters (o) and Soft Shell Clams (c)

PCB or Pesticide	Species	Range (ppm)	Mean (ppm)	Standard deviation (ppm)	Median (ppm)	# samples positive / Total # of samples	% samples positive
PCB 1254	o	0-0.10	0.04	0.03	0.05	23:28	82
	c	0-0.10	0.04	0.03	0.04	37:48	77
PCB 1260	o	0-0.03	0	0.01	0	5:28	18
	c	0-0.07	0	0.01	0	5:48	10
Chlordane	o	0.01-0.08	0.04	0.02	0.04	28:28	100
	c	0.02-0.12	0.04	0.02	0.03	48:48	100
DDD	o	0-0.030	0.007	0.008	0.004	20:28	71
	c	0-0.030	0.008	0.006	0.006	40:48	83
DDE	o	0-0.009	0.001	0.002	0	5:28	18
	c	0-0.030	0.005	0.008	0	23:48	48
Dieldrin	o	0-0.040	0.009	0.010	0.006	26:28	93
	c	0-0.060	0.012	0.013	0.009	47:48	98

Figure 4 shows the comparison between oyster and soft shell clam PCB and pesticide means in graph form. Significant differences between species according to the Student's *t*-test at the 5% level are indicated at the top of each column.

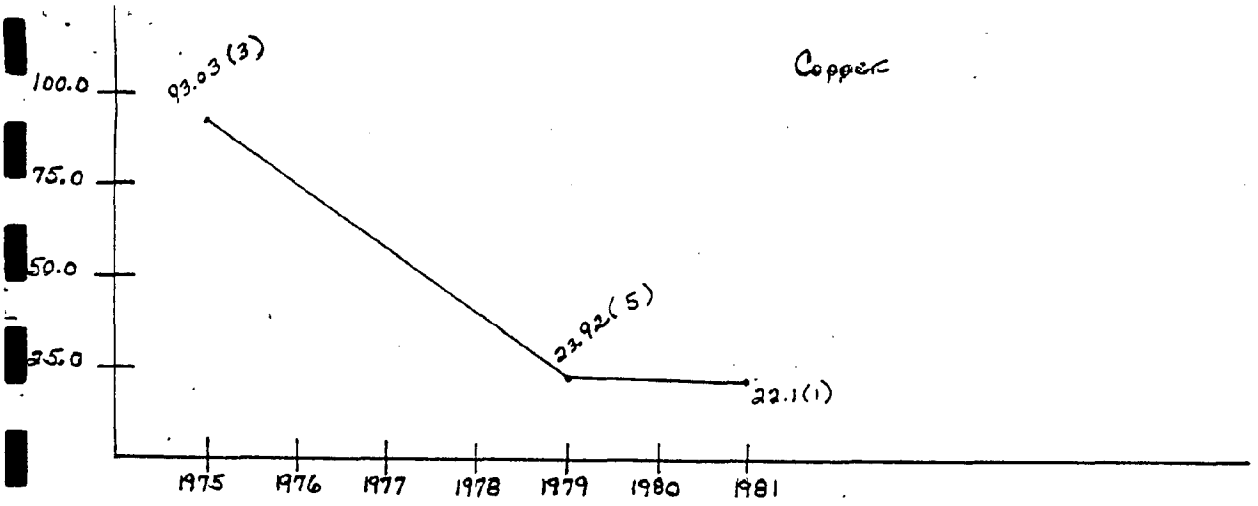


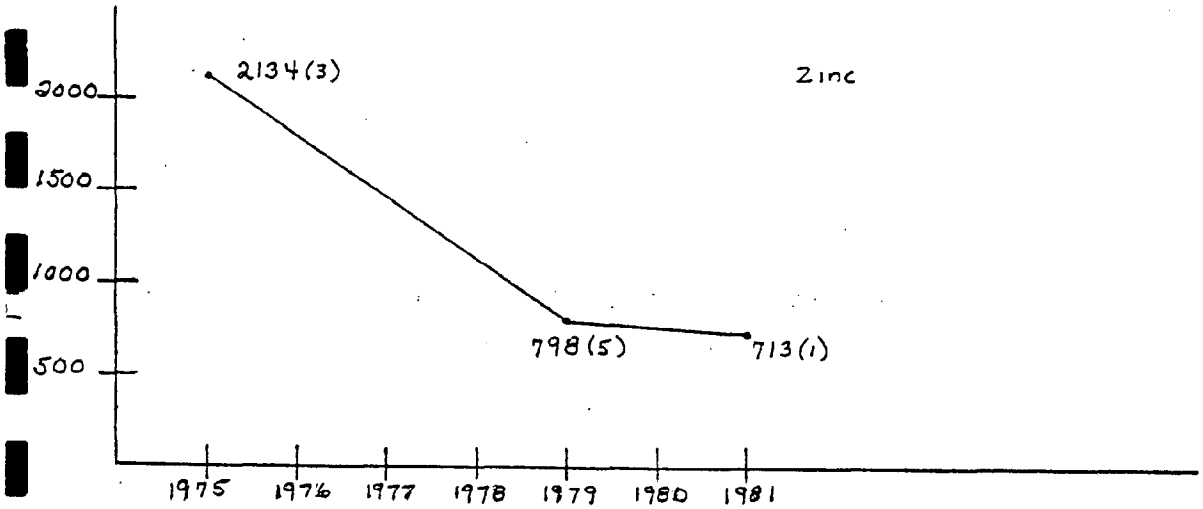
*NS=Not significant and S=Significant according to Student's t-test at 5% level

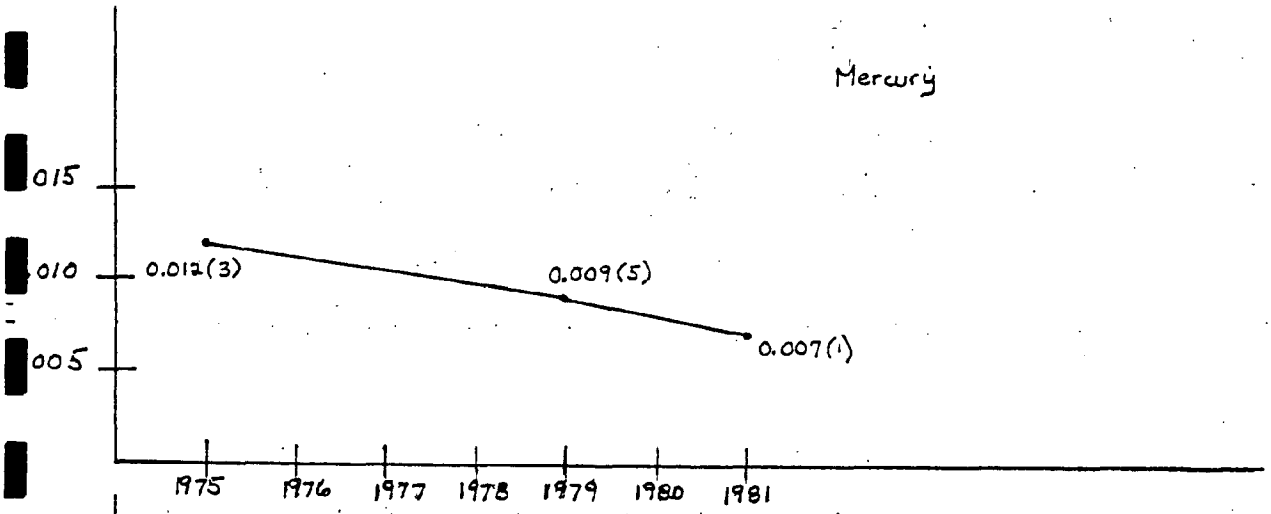
Figure 4 PCB and pesticide means in soft shell clams (c) and oysters (o) from the Kent Island Coast

Year Trends

Graphs of oyster heavy metal, PCB and pesticide means for 1975, 1979 and 1981 are shown in Figures 5 and 6. Gaps in the data prevented extensive statistical evaluation. Copper, zinc, mercury, cadmium, PCB 1254, chlordane, DDD and dieldrin levels all decreased from 1975 to 1981.







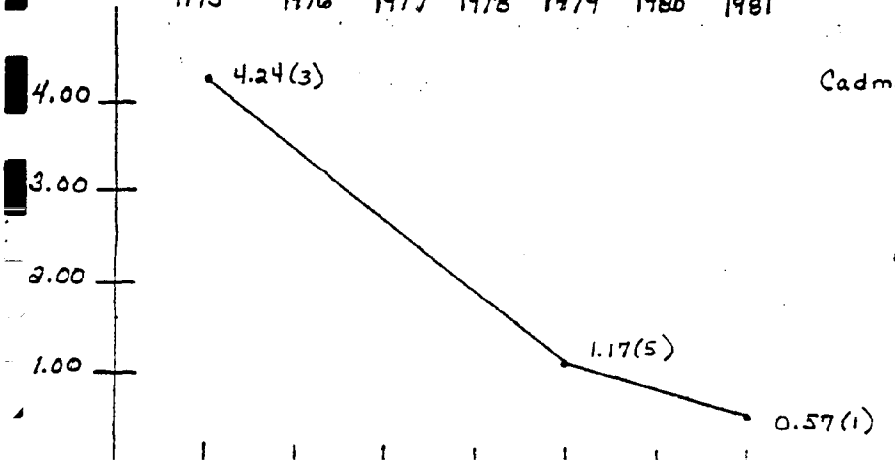


Figure 5 Graphs of Heavy Metals in Oysters from different Years

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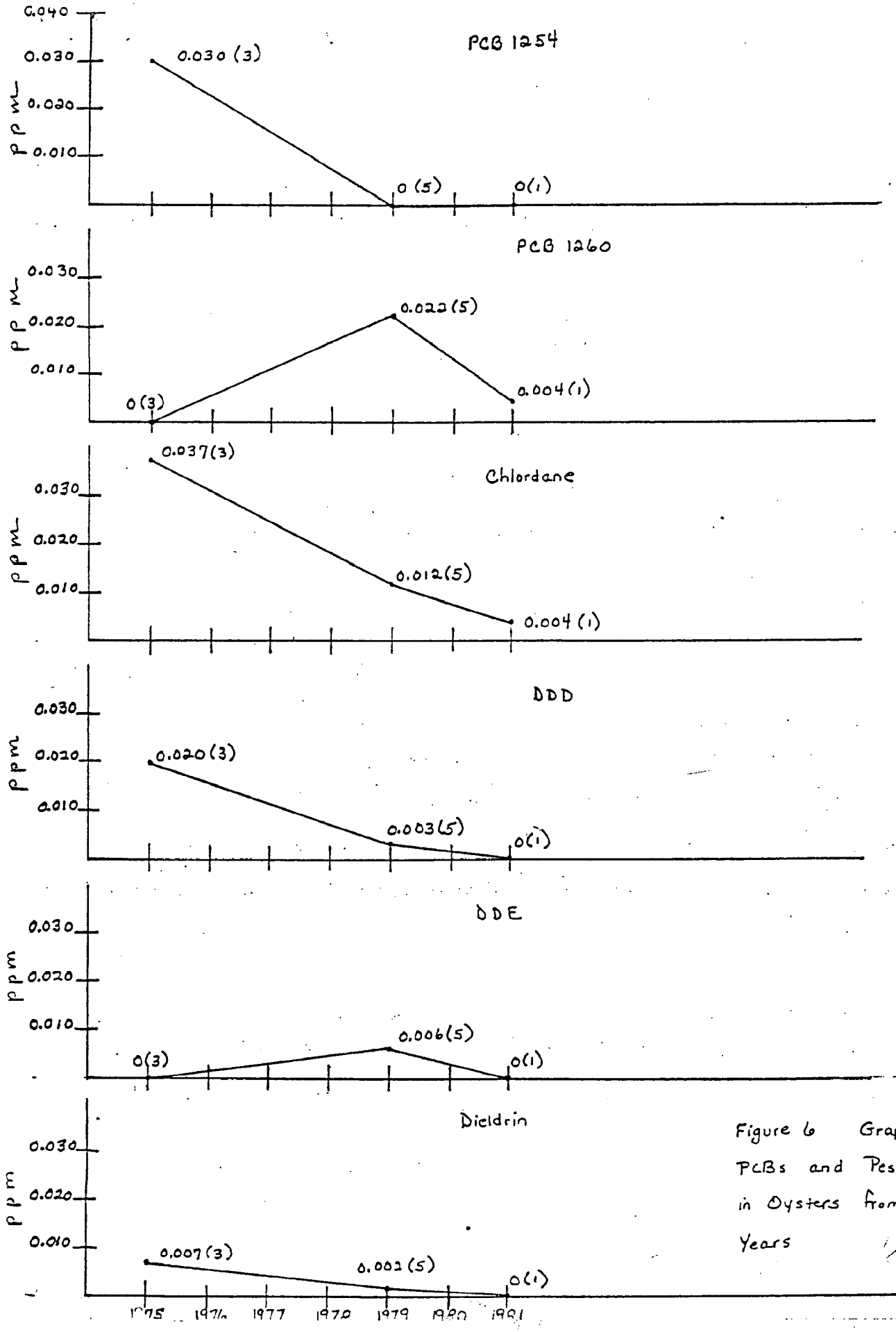

Figure 6 Graphs of PCBs and Pesticides in Oysters from Different Years

Discussion

This report is the second in a series of reports on heavy metal, PCB and pesticide levels in shellstock from different areas of the Chesapeake Bay and its tributaries. The first report, *"Heavy Metal, Polychlorinated Biphenyl, and Pesticide Levels in Oysters (Crassostrea virginica) and Soft Shell Clams (Mya arenaria) from the Choptank River, Maryland"*, includes an extensive literature review of heavy metal, PCB and pesticide uptake in shellstock. Comparisons with the Kent Island coast data were limited in scope due to gaps in the sampling.

Kent Island coast copper, zinc, mercury and cadmium means were significantly higher in oysters than in soft shell clams. This was consistent with metal differences between oysters and soft shell clams found in the Choptank River study, except for mercury means which were not significantly different in Choptank River oysters and soft shell clams. Heavy metal levels were higher in the Kent Island coast oysters and soft shell clams than in those from the Choptank River. These differences may be the result of variability in exposure to man's activities or variations in natural conditions or a combination of these factors.

PCB and pesticide means in Kent Island Coast oysters and soft shell clams were not significantly different with the exception of DDE means. This finding was not consistent with the Choptank River findings were no significant difference in concentration by was found for DDE. On the other hand, in the Choptank River, there was a significant difference between oysters and soft shell clams in PCB 1260 means. In general PCB and pesticide levels were higher in the shellstock from the Kent Coast than in shellstock from the Choptank River.

Land use along the Kent Island coast is generally confined to scattered subdivisions. A few large marinas exist but during the time of this study

no major point source discharges existed. A new sewage treatment plant will begin discharging off the coast just north of the Bay Budge in the fall of 1981. The effluent will be discharged into 40 feet of water at the edge of the channel and is expected to have no advise impact on the shellstock along this coast. Background data like this report provides is essential in evaluating any subsequent impact attributed the sewage treatment plant.

An attempt was made to determine year trends in heavy metal, PCB and pesticide levels in shellstock collected along the Kent Island Coast. Although gaps in the data prevented any in-depth year trend analyses, a possible trend was suggested by the 1975, 1979 and 1981 oyster heavy metal means and several pesticide means. A gradual decrease in copper, zinc, mercury and cadmium levels from 1975 and 1981 was indicated. PCB 1254, chlordane, DDD and dieldrin exhibited similar trends. The Maryland area has been experiencing a drought for approximately the past five years with subsequent low levels of runoff thereby possibly reducing the amounts of heavy metals and pesticides entering the waterways. In addition, salinities are high throughout the Bay region as a result of the drought. Previous research by Huggett et al. (1975) suggested that an inverse relationship exists between salinity and heavy metal levels in shellfish tissues.

Although extensive analyses were not possible these trends are noted because of their possible significance. As the lead agency responsible for water quality in Maryland, it is necessary for the Office of Environmental Program to monitor any changes that may occur in the environment. As more data becomes available the significance of apparent trends can be determined.